CITRUS

Vol. III

Insect Pests and Diseases

Preparation of Citrus Products

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Published by

THE HYDERABAD FARMERS' UNION,

HACA House, Hyderabad-Dn.

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CITRUS

Part I

Insect Pests on Citrus

A large number of insects have been found to injure citrus trees and sometimes cause considerable damage. Indian growers have fortunately to contend against a less number of insect enemies than growers in other countries. They however have a fair share of the trouble and have to be always alert lest the enemy should get the better of them and make them suffer. Citrus pests in general may be divided into 3 distinct groups; the biting insects, the borers, and the sucking insects.

The most injurious among the biting insects are the following;—

1. **The Lemon Cater-pillar.**—(Papilio demoleus).

This is a dirty looking caterpillar resembling the droppings of a bird when young and later developing into a large green caterpillar. When disturbed it protrudes a pair of horn like feelers and emits a liquid having a repellant smell. The caterpillar eats voraciously and causes much damage in a short time. When present in large numbers the entire foliage of the trees, is eaten up. The adult insect is a gorgeous looking butterfly. The female lays hundreds of eggs usually on the tender shoots.

Treatment:—In the nursery where it does much damage to the young plants it may be easily destroyed by hand picking. Lead arsenate solution or paris green at the rate of 4 ounces to 10 gallons of water or DDT 50% W.P. at the rate of one pound in 30—40 gallons of water may be sprayed on the foliage of the attacked plants.

Two other caterpillars are reported to damage the leaves and young shoots in citrus plantations. One is the orange leaf caterpillar (Tomica zizyphi) which folds the tender leaves over its slender light green body and a brown head, and the other the orange hair streak (Tarucus theophrastus) which has a short thick body and is very slow moving. They are however of minor importance and have never been found to do serious damage.

2. Orange Leaf Roller (Phyllocnistis citrella).

The adult of this caterpillar, a small moth, lays very minute eggs on the leaves and young shoots. The larvae on hatching bore under the epidermis and makes zig zag tunnels feeding on the sap. The tender leaves when attacked roll up and further growth is arrested. The damage done is not usually great but the tunnels may afford an easy means for the canker disease to enter into the leaves and cause damage. As the insect works below the surface it is difficult to control except by removing the infested leaves. Spraying with nicotine sulphate **(1: 600 parts)** or 50% W.P. DDT at 1 lb. in 40 gallons will reduce the attack.

3. Scale Insects:—These belong to the sucking group and several types have been found in plantations in different parts of India attacking both leaves, twigs, or fruits. They attach themselves to the surface of stems and leaves and suck up sap causing them to gradually dry up. Fruits infested with this insect lose their vitality and appearance.

Treatment:—Spraying with a contact insecticide keeps this pest under check. Spraying with fish oil rosin soap at the rate of 1 lb. in 4 gallons of water or folidol E 605 (3 ccs per gallon) is advised. In other countries fumigation with hydrocyanic acid or powdered calcium cyanide is common. It is expensive and not very safe and practicable under our conditions.

The following species have been reported to cause damage to citrus trees.

(1) The florida red scale—Chrysomphalus aonidum from Bombay;

(2) California Red scale—**Chrysomphalus** aurantii from Ranchi on Grape fruits;

(3) Red scale—**Aonidiella aurantia,** Yellow Scale—**Aonidiella citrii;** Oriental yellow scale, **aonidiella orientalis,** and **chrysomphalus faci** from the punjab.

4. **White flies:**—A number of species of these insects attack citrus plants. They are also known commonly as mealy wing. Only the leaves are affected but the damage sometimes is considerable. The insect is most active during the months immediately after the rains. The insect appears to be more common in Punjab than in other citrus growing tracts of India. General species known as citrus white fly and black spiny fly; the black fly and the orange spiny white fly are distinguished.

Treatment:—Fish oil rosin soap and phosphatic compounds have been used successfully in controlling the pest. Tobacco decoction has also been found to be very effective.

5. **Aphids:**—These are small greenish or dark coloured insects that give citrus growers considerable trouble from time to time. They attack the growing extremeties of citrus trees such as the young leaves, twigs, buds, blossoms and fruit. When severe, the injury caused by these tiny insects results in the curling up of leaves and eventually in the complete destruction of the leaves and young twigs. Flower buds fail to develop and blossoms do not set fruit. In very severe conditions the crop may be entirely lost. If the fruit has attained some size before injury, it becomes distorted. The insects are not capable of injuring mature leaves or hardened twig. It is only the new growth that falls an easy prey to its attacks. The loose skinned oranges are the worst sufferers but sweet oranges also are severely injured. Grape fruit, it is said, is almost immune to aphid attack.

Treatment:—Control measures have to be taken sufficiently in advance as once the leaves and twigs get curled or twisted it becomes very difficult to reach them. Destruction in very early stages of attack is more effective than control measures after the aphids have established themselves. Spraying with fish-oil rosin soap 2 ounces in 1 gallon of water, nicotine sulphate (1:800) and Folidol E 605 (2 ccs per one gallon) or Endrin 3 ccs per gallon can give effective control.

6. **Mites:**—These are minute spider like organisms hardly visible to the naked eye. They attack both the leaves and the fruit. The leaves lose their glossy colour and become covered with brownish white spots. The rind of the fruit is also covered with spots and if the attack is severe the fruits do not develop normally. Spraying with lime sulphur solution or dusting with sulphur or spraying Folidol E 605 at the rate of 3 ccs per gallon are effective against them.

7. **Thrips:**—Sometimes the surface of citrus fruits are found with irregular shaped white scars, which lessen the market value of the fruit. The scars are very irregular being in streaks, blotches or circles. The injury is supposed to be caused by thrips which attack the flowers. They feed on the flowers by sucking the juice from petals and other parts and while feeding injure the surfaces of small fruits. These injury marks are very small at first but grow with the development of the fruit. Treatment consists in spraying or dusting. Endrin at 2 ccs per gallon or nicotine sulphate (1:600) will give effective control.

8. **Borers:**—Very often in old and neglected orchards a large number of trees have some portion of the stems covered with strips of knitted silky material made up of the excreta of insects indicating the presence of the borer in the near vicinity in a small hole usually in the bottoms of forked branches. If these peculiar patches loosely attached to the bark are removed the bark immediately underneath will be found to be eaten by the borer. The borer appears to be active only during nights retiring to the

holes made by them, during the day. If neglected the borers are capable of severely damaging and sometimes destroying the trees.

Some species are common in India of which the following are the more important:

(1) Bark eating caterpillar Arbela tetraonis

(2) Orange Beetle Borer Stromatium larbatum

(3) Chelidonium cinctum

The silky knitted material should be removed and the bark covered with paris green (1 ounce in 2 gallons of water) or a few drops of a mixture of 2 parts of chloroform and 1 part of creosote or petrol should be injected into the holes and the mouth of the hole plugged. In early stages when the hole is small it is possible to kill the insect inside by thrusting a piece of wire into the hole and moving it up and down a few times.

9. **Citrus Fruit Sucking Moths:**—One of the most serious pests on orange fruit in India is the fruit sucking moth which punctures and sucks the juice of fruits usually at the time of ripening. The attacked fruits start rotting and fall off from the trees within a few days. The moths are nocturnal in habit and are active from about eight in the night to 2 O'clock in the morning.

There are several species of which two are quite common and well known:—**Ophideres fullonica** and **O. maternae.** The former which is much in evidence in almost all the citrus growing parts of Hyderabad is a stout moth with the upper wings of greyish colour and the lower ones bright orange having conspicuous black markings.

Treatment:—In some tracts the pest is so abundant that growers think it safe to avoid the ambebahar crop which is more subject to its attack. In several orange tracts the mature fruits are covered with bags made from

palmyrah leaves or butter paper, which effectively prevents damage by the moths. These moths have alternate host plants and if those are destroyed it is possible to control the pests in the larval stage. **Tinaspore cardifora** and **Cocculus hirsutus** are the host plants for the larvae of these moths. A poisoned bait flavoured with pine-apple juice to make it attractive to the moths is used effectively in controlling the pest. In Aurangabad District an experienced fruit grower Mr. H. B. Mehta used to successfully control the moth by employing small boys to catch moths with the help of torches for a small monetary consideration and then feed the insects caught during the night to his poultry in the morning after killing them. Bagging the fruits for preventing attacks, results in the rind getting coloured prematurely. Dusting 5% BHC or smoking with BHC may reduce the attack.

Citrus Diseases.

In India the number of diseases affecting citrus is not very large but some of the diseases that are usually associated with the cultivation of the fruit are of sufficient importance to command the attention of growers. Some conditions of location are conducive to certain diseases and it is best to avoid these, it is well nigh impossible to correct fundamental defects in soil, climate and drainage. Some diseases are associated with the systems of cultivation, irrigation and manuring and; negligence and lack of proper treatment are responsible for others. To succeed with citrus the grower should be equipped with knowledge of the way in which the diseases are spread and methods of combating them.

Many diseases are caused by fungus attacks which injure the different parts of the trees the stem, roots, branches, or leaves, and prevent them from functioning properly. Some attack the fruit and either destroy it or make it unfit for the market. Fungus diseases are spread by their seeds which are known as spores, and are as small as dust particles .These are easily scattered by the wind or rain and under congenial conditions enter the tissues of living plants,

The most common diseases that citrus plantations are subject to, are mottle leaf, dieback, canker, mildew, leaf and fruit fall, sooty mould, root and collar-rot, gummosis, fruit shedding, withertip or anthracnose, cracking of fruit, tambera and scab.

1. **Mottle leaf or Frenching:**—The most conspicuous symptom of this disease is a characteristic mottling of the leaves, yellow areas develop between the veins which in bad cases may be continuous near the margins. The leaves are smaller than normal and the twigs are small and weak. The disease affects the growth and development of the trees and the yield of fruit.

The trouble is supposed to be due to zinc or iron deficiency in the soil or their unavailability to the plants. Spraying with zinc sulphate lime mixture in the porportion of 10 pounds of zinc sulphate, 5 pounds of lime and 100 gallons of water usually cures this disease. Some times applications of ferrous sulphate alone brings about results. Application should be done 4-6 times in the season at weekly intervals.

2. **Dieback:**—Strictly speaking dieback is not a disease but a group of symptoms which though varying under different conditions bring about ultimately the same result, the death of the tree. The santra orange is the most susceptible to this disease, the mosambi and grape fruit coming next. Limes and lemons and rough lemon are comparatively more resistant. Individual trees groups of trees or whole plantations are affected. The disease starts making its appearance in all stages of growth, very young trees being also affected under extreme conditions.

The cause of this disease is not known. Lack of proper nutrition, abnormal moisture conditions, poorly drained soils, an uncongenial subsoil, want of sufficient organic matter, or very heavy soil seem to be important factors that predispose the trees to this trouble. The disease starts with the yellowing of the leaves on a part

of the tree which gradually extends to other parts and moves downwards till a stage is reached when sometime before death only the basal portions of the main branches remain with a few yellowing sprouts upon them. The root also starts drying up or rotting as per the soil condition.

Treatment:—The best that can be done is to take such measures as will correct, improve or minimise the defective drainage by the opening of trenches between the lines of trees and; improve orchard practices to provide good aeration go a long way in restoring affected plantation back to health. Application of micro-nutrient elements in many cases restores plantations.

3. **Canker:—Pseudomonas citri** or **Phytomonos citri.** Citrus canker is one of the most destructive diseases and in many cases the destruction of the trees provides as the only safe remedy. While most of the citrus varieties are more or less susceptible, the sour lime appears to suffer the most, the santra and the pummelo are almost immune to the disease.

It is a bacterial disease and spreads by wind, rain irrigation water, plants, birds or animals. Conditions of climate also have a marked effect; very congenial conditions prevail during the rains. The disease affects the leaves, twigs, thorns and the fruits on which brownish spots appear which become raised and rough.

Treatment:—Much can be done to prevent spread of the disease by pruning away all the affected parts, burning them, and spraying the entire plants with bordeaux mixture (5:5:50) repeatedly.

4. **Powdery Mildew (Oidium tingitanium):**—The leaves and twigs get covered with a whitish powder and affected trees fail to open their flower and cause low fruitset. Dusting with fine sulphur powder has been found useful.

5. **Leaf and Fruit fall:**—This disease is caused by a fungus **(phytopthora species)** and is especially severe in tracts subject to heavy rainfall or during periods of excessive rains. The loose skinned oranges are very susceptible. Water soaked areas appear on the leaves and small fruits and; both start falling off from the tree in large numbers. In severe cases a whole crop is completely destroyed.

Treatment:—As soon as the symptoms are manifest the tree should be sprayed with 3-3-50 or 5-5-50 Bordeaux mixture.

6. **Sooty Mould (Meliola sp.):**—This disease is found in regions of heavy rainfall and great humidity. It is intimately associated with scale insects and allied species which exude honey dew. The honey dew exuded by the insects fall upon the upper side of the leaves, beneath and upon the twigs and fruits. These soon get covered with a black sooty covering and are thus deprived of sunlight. Leaves cease functioning, bearing is affected, the quality of fruit is impaired and uniform ripening of the fruit is prevented.

Treatment:—Destroying the insects responsible for the honey dew should be dealt with in time. If they are destroyed the disease does not appear. Tobacco decoction, nicotine sulphate and fish oil rosin soap are effective against insects.

7. **Sudden wilt or root rot:**—This is a very destructive disease and almost impossible to control. Santra and mosambi trees, for no apparent cause, start wilting suddenly. The roots are found to be rotting, the bark sloughs off easily, and the diseased portion has an offensive smell. No treatment has been of any real use. Whole plantations are found, every where under various conditions of soil and water, being wiped out. As however, there is possibility of the disease spreading from tree to tree by irrigation water, the spread of the disease may be prevented by removing the affected tree and isolating the

area occupied by it, by digging a ring of trench round it which should then be sterilised by burning some suitable material, grass, leaves or wood. Control measure applied in the case of dieback proved effective in this case also. Right cause is to be found first.

8. **Collor Rot or Mal-di-Goma or Foot rot (Phytophthora Sps; Diplodia and Fusarium Sps):**—This disease is confined to the basal portion of trunk and the roots immediately below.

Its presence is indicated by drops of gum appearing on the bark. If neglected the disease continues to spread till the trunk is entirely girdled, and kills the tree ultimately. Insanitary conditions surrounding the base of the tree trunk influence the virulence of the disease. The disease occurs in plantations standing on very heavy soils or on sites with a high watertable and where water-logged conditions prevail. Close planting of trees causing undue shade underneath, low planting, injury to root and bark and prolonged contact of the trunk with moisture are other causes which aggravate conditions which bring in the disease. Sweet oranges, citrons, vadlapudi oranges are highly susceptible to the disease and lime and lemons are fairly resistant to it.

Treatment:—The conditions detrimental to the health of the orchard should be removed first. To treat the affected trees, earth round the base of the trunk should be removed carefully without injuring the roots lying below and cleaned with water. The diseased portions should then be cut out to the healthy wood, and painted with bordeaux paste or lime sulphur solution. Badly damaged and girdled trees may be renovated by planting a couple of stocks around the affected tree and grafting them above the injured part of the tree. The disease is prevented by using root stock which is resistant to the disease.

9. **Gummosis (Phytophthora** and **Pythium Sps.):**— Generallly the parts affected by this disease are the trunks

and the larger branches. The mosambi and pummelo are highly susceptible and santra less so, and the acid lime and the jamburi are resistant. Among the predisposing conditions that cause the disease are injuries to the trunk, deep planting, low planting, water-logged conditions created by heavy irrigations, heaping up of soil round the tree trunks, and prolonged contact of the trunk with irrigation water. The first indication of the disease is the exudation of drops of gum from the bark of the trunk. The bark cracks more or less extensively, dries up in course of time and falls off exposing the wood below. If unchecked the disease spreads, girdles the trunk completely and causes death.

Treatment:—Infection takes place through the injured portion of bark and the bud joint affording facility for the causal fungus to enter. The following preventive and remedial measures should be taken to combat the disease:—

1. Only trees budded on resistant root stock should be planted.
2. The bud joint of the planted tree should be beyond the reach of irrigation water standing in the basin.
3. Trees should not be planted deep or with the bud joint below the surface of the ground.
4. Soil should not be heaped up round the base of the trunk.
5. Excessive irrigation especially in heavy soils should be avoided.

When infection has taken place, and has not advanced too much, successful treatment of the affected part is possible. The diseased bark should be cut away at least half an inch beyond the disease area on all sides. If the injured bark is not removed carefully, the fungus is likely to reappear after treatment. The area operated upon

should be covered with bordeaux paste, or a paste made of one pound of zinc sulphate, one pound of copper sulphate, two pounds of lime and two gallons of water, or painted with a mixture of equal parts of carbolic acid and water. The last should be applied with brush.

10. **Fruit Shedding:**—Local weather conditions appear to be responsible for the occurence of this. Sudden change from dry to wet, or hot to cold, dry spells during or immediately after blooming period cause the fruit to shed. Treatment consists in ameliorating adverse weather conditions by providing wind breaks, growing intercrops and ample supply of water during dry spells.

11. **Wither Tip of Anthracnose (Colletotrichum gleosporoides):**—In the northern parts of India this disease is widely prevalent. It affects the twigs, branches, fruit and leaves and sometimes is also responsible for flower and fruit fall. Twigs when attacked soon wither and die, branches are killed directly or by poisonous substances produced during the growth of fungus, leaves either turn yellow or drop and the fruit is covered with red spots which later become dark in colour. At an advanced stage the rind is destroyed and decay results.

Treatment:—Treatment consists in preventing the disease by keeping the trees in vigorous healthy condition and spraying with bordeaux mixture.

12. **Cracking of fruit:**—This frequently occurs in limes and lemons more than in other species — santras or mosambis. This is caused by irregular irrigation and manuring. Care should therefore be taken to irrigate orchards at definite and regular intervals and apply manure according to the normal requirements of the trees.

13. **Tambera:**—The fruit of the mosambi is sometimes seen with broad brown patches on the surface of the wind. This is due to attack by an insect known as mite. This disease is often severe in plantations where moist conditions prevail all the year round and when the

plantations are over—irrigated. Judicious watering and spraying fruits with lime sulphur solution or dusting with sulphur keeps the disease in check.

14. **Scab (Sphaceloma fawcetti):**—Occurs only in tracts with a very low temperature and therefore is not much in evidence in India. It is however, very often confused with canker.

Part II

HOME SCALE CITRUS FRUIT PREPARATION SERIES.

PREPARATION & PRESERVATION OF ORANGE SQUASH.

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1. **Selection of fruit:**—Select fresh, fully ripe and sound oranges. Tight-skinned oranges should preferably be graded according to size to fit the size of the rose of the cone type juice extractor (rose being changeable according to the size of the fruit).

2. **Preliminary treatment:**—Wash the fruit thoroughly in water or in very dilute solution of hydrochloric acid (1:20) to remove the residual spray material, and then in running cold water in small lots at a time to remove all dust, soil and other extraneous matter.

3. **Preparation of the fruit:**—Cut the tight-skinned oranges into halves or remove the peel and break into segments the loose-skinned oranges.

4. **Extraction of the juice:**—Extract the juice with a cone type handworked (wheel type*) or electrically worked juice extractor (Mix Master)* in the case of tight-skinned oranges and with a screw type juice extractor* for the segments of the loose skinned oranges. Strain the juice through a coarse muslin cloth.

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*This type of equipment can be had from food machinery dealers like Messrs Gardners Corporation, Connaught Circus, New Delhi; and Gladwyn & Co., Hornby Road, Bombay.

5. **Recipes:**—The following recipes have been evolved on the basis of the experimental work in the Fruit Products Laboratories at Lyallpur under the auspices of the Indian Council of Agricultural Research:—

		Recipe I (33 p.c. Orange juice)	Recipe II (57 p.c. Orange juice)	Recipe III (60 p.c. Orange & lime juice)
(i)	Juice	4 lbs.	4 lbs.	2 lbs.
(ii)	Sugar	5 lbs.	3 lbs.	2 lbs.
(iii)	Water	3 lbs.	—	—
(iv)	Citric acid	3 oz.	1¼ oz.	—
(v)	Lime, Lemon or Galgal Juice	—	—	1 lb.

(vi) Essence:— Peel emulsion of 2-4 oranges for every 100 fruits used or by adding a suitable dose of fruit essence or oil.

(vii) Orange colour:—Suitable quantity of edible orange colour to bring out the desired shade of colour in the finished product.

Note 1:—In the case of Recipe I above, sugar syrup is first prepared by heating the mixture of sugar and water straining the same through a coarse muslin cloth. This syrup is cooled and then mixed with juice etc.

Note 2:—Peel emulsion is made by crushing the peels in a pestle and mortar and squeezing the crushed pulp through a thick cloth.

6. **Mixing and preservative:**—Mix the above quantities of the ingredients thoroughly and strain through a coarse muslin cloth. Finally add the preservative i.e.

potassium metabisulphite at the rate of 5.0 grains per lb. (or ½ mash per bottle of 26 oz. capacity) of the finished product.

Note:– The preservation which can be had from any chemicals supplier or any branch of the Imperial Chemical Industries, should be dissolved in a small quantity of water or the finished product and then mixed with the rest of it.

7. **Bottling and storage:**—Pour the finished product into bottles (which have been previously heated in boiling water for 15-20 minutes) leaving 1″-1½″ space at the top. Cork airtight either with crown cork seal or by ordinary cork slightly wetted; and store the bottle in a cool, dry place.

PREPARATION AND PRESERVATION OF LIME AND LEMON SQUASH

1. **Selection of fruit:**—Select fresh, fully ripe fruit free from bruises and particularly from fungal attacks. The bigger size fruit of the lemon species should be graded according to size.

2. **Preliminary treatment:**—Wash the fruit thoroughly under a spray of cold water, preferably in small lots at a time to remove dirt, spray material and other extraneous matter.

3. **Preparation of the fruit:**—Cut the fruit into halves with sharp stainless steel cutting knives.

4. **Extraction of the juice:**—Extract the juice with lime squeezers or in a small basket press in the case of limes or with a cone type juice extractor (Mix Master)*

*This type of equipment can be had from food machinery dealers like Messrs Gardners Corporation, Connaught Circus, New Delhi, and Gladwyn & Co., Hornby Road, Bombay.

in the case of lemons. Strain the juice through a coarse muslin cloth to remove seeds and coarse pulp.

5. **Recipes:**—The following recipes have been worked out on the basis of the experimental work conducted in the Fruit Products Laboratories at Lyallpur under the auspices of the Indian Council of Agricultural Research:—

		Medium sugar Squash.	High Sugar Squash.
Juice	...	4 lbs.	1 lb.
Sugar	...	5 lbs.	2 lbs.
Water	...	3 lbs.	3 ozs.

Note:—(1) A suitable quantity or edible yellow colour is added to bring out desired shade of colour in the finished product.

(2) For recipe with high sugar content the ingredients may be mixed by slight warming, if necessary.

6. **Mixing and preservative:**—Mix the above quantities of the ingredients thoroughly and strain through a coarse muslin cloth. Finally add the preservative i.e. potassium metabisulphite at the rate of 5.0 grains per lb. (or ½ masha per bottle of 26 ozs. capacity) of the finished product.

Note:—The preservative which can be had from any chemical suppliers or any branch of the Imperial Chemical Industries should be dissolved in a small quantity of water or the finished product and then mixed with the rest of it to ensure uniform mixing.

7. **Bottling and storage:**—Pour the finished product into bottles which had been thoroughly cleaned and previously heated in boiling water for 15-20 minutes leaving a head space of 1-1½ inches. Cork air-tight either with crown-cork seal or with ordinary cork (slightly wetted and pushed in). Store the bottles in a cool, dry place.

PREPARATION AND PRESERVATION OF LIME JUICE CORDIAL

1. **Selection of fruit:**—Select fresh, fully ripe lime (Nimbu or limu) free from bruises and particularly from fungal attacks.

2. **Preliminary treatment:**—Wash the fruit thoroughly under a spray of cold water preferably in small lots at a time to remove all dirt, spray material and other extraneous matter.

3. **Preparation of the fruit:**—Cut the fruit into halves with sharp stainless knives.

4. **Extraction of the juice:**—Extract the juice with limesqueezers or in a small basket press* and strain the juice through a coarse muslin cloth.

5. **Clarification:**—Store the juice in large sized glass containers Winchesters or Carboys, adding preservative i.e. potassium metabisulphite at the rate of 10.0 grains per lb. of the juice. Let the juice settle without disturbing the sediment and then strain it through a fine muslin cloth.

6. **Recipes:**—The following recipes have been worked out on the basis of the experimental work conducted in the Fruit Products Laboratories at Lyallpur under the auspices of the Indian Council of Agricultural Research:

	Medium Sugar Cordial	High Sugar Cordial
Juice	... 1 lb.	1 lb.
Sugar	... 1¼ lb.	2¼ lb.
Water	... 1 lb.	3 ozs.

*This type of equipment can be had from food machinery dealers like Messrs Gardners Corporation, Connaught Circus, New Delhi, and Gladwyn & Co. Hornby Road, Bombay.

7. **Mixing and preservation:**—Mix the above ingredients thoroughly slightly warming, if necessary. Strain the product through a fine muslin cloth. Finally add the preservative i.e. potassium metabisulphite at the rate of 2½ grains per lb. of the finished product.

Note:—The preservative which can be had from any chemicals supplier or any branch of the Imperial Chemical Industries should be dissolved in a small quantity of water or the finished product and then mixed with the rest of it.

8. **Bottling and storage:**—Pour the finished product into bottles which have been thoroughly cleaned and previously heated in boiling water for 15-20 minutes leaving 1″-1½″ space at the top. Cork air-tight with crown cork seal or by ordinary cork slightly wetted and pushing it tightly. Store the bottles in a cool dry place.

CANNING AND BOTTLING OF FRUITS

1. **Selection of fruit:**—Select fresh, firm, fully developed and sound fruits. For best flavour and appearance, use only the choice fruit of uniform maturity, colour etc. If fruits have to wait* they must be kept in a cool and well ventilated place.

2. **Washing:**—Wash the fruit thoroughly in small lots in running water or several changes of water, if possible, to remove dirt and other extraneous matter. Handle fruit carefully to avoid bruising.

3. **Preparation of fruit:**—Prepare the fruit as described under column 3 of the table annexed.

4. **Filling and syruping:**—Use cans and glass jars which have been previously heated in boiling water for

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*This is a small and compact simple machine available from the Metal Box Company of India Ltd., Calcutta, who can also supply tin cans for use.

about quarter of an hour. (Jars should be dipped in cold water which is gradually heated to boiling to prevent breakage). Pack desired weight* of prepared fruit. Pour boiling hot syrup leaving about ½ inch space on top of the can or jar. (See table for strength).

*One lb. butter size can and pint glass jars ... 8-10 oz.
A 2½ size can. ... 18-20 ozs.

5. **Exhausting:**—This means to heat the filled can or bottle (before sealing) to drive out air in the fruit tissues and this helps preventing discolouration and loss of flavour during storage. For this, place the open filled cans and jars in a large kettle with boiling water about 2″ below the tops of the containers. Cover kettle, bring the water to boil till the centre of the can or jar records a temperature of 160-170°F. This will be accomplished in about 10 minutes.

6. **Sealing:**—Remove cans or jars individually from water while hot. Replace any liquid spilled by adding boiling hot syrup. Place a clean lid on filled can and seal by a Home Can sealer* and seal-jar with screw caps.

7. **Pasteurisation:**—Put the sealed containers in a large pan containing hot water, its bottom being covered with a thick clean cloth. (This is done to avoid breakage of glass jars and bumping of the containers during subsequent boiling), keeping the level of water an inch or two over the tops of containers. Cook different fruits for periods as indicated in the table (counting time as the water comes to rolling boil), to kill all germs, bacteria etc.

8. **Cooling and storage:**—Cool cans quickly preferably in running cold water, take them out while they are slightly warm so that they will dry in the air. Place glass

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*This is a small and compact simple machine available from the Metal Box Company of India Ltd., Calcutta, who can also supply tin cans for use.

jars each separately for cooling in air taking care not to expose hot jars to cool surface, water or air draught. When cool, stock in a cool dry place.

***Note:**—(1) In case of mangoes, musk melon and papaya 5.0 grains of citric acid per lb. of syrup may be added with advantage because of the sweetness of fruit.

(2) Pack tomatoes to top, add common salt ½ teaspoon in one lb. butter size can and pint glass jar, and 2½ teaspoons in a 2½ size can and fill with boiling hot water.

(3) The canning table has been compiled for fruits generally available in this country and is based on the experimental work conducted at Lyallpur and Delhi under the auspices of the Indian Council of Agricultural Research. Some data have also been collected from the foreign literature available on the subject.

***Note:** All cooking times are given to work at sea-level. At higher altitudes increase cooking time by two minutes per each 1,000 ft. rise in altitude.

CANNING TIME TABLE FOR FRUITS AND TOMATOES

Fruit	Methods of preparation	Syrup strength*	Kind of can	Cooking time in minutes in boiling water—212° F.* Size of can 1 lb. butter	A2½	Glass jars pint
1	2	3	4	5	6	7
1. Apricots	Halve the fruit around the pit suture, remove pit may also be canned as sholes.	Heavy	Plain	25	30	20
2. Berry fruits (except straw berries)	Remove stems.	Medium	Lacquered	15	20	15
3. Cherries	Remove stems and pits.	Medium	,,	15	20	20
4. Figs	Remove stems, dip the fruit in water at 150°F. (5-10 mts.) if the fruit has waxy coating.	Heavy	,,	100	110	100
5. Grapes	Stem individual berries.	Light	Plain	12	15	15

6. Grape fruit	Soften fruit in hot water (200°F. for 2 to 5 (mts.) remove skin of individual segments with special curved knives.	Heavy	,,	20*	25*	25*
				*In hot water at 180-190°F.		
7. Guava	Peel, halve or quarter, remove seedy portion-steep in 2% common salt solution. Wash before pack.	Medium	,,	25	30	30
8. Litchi	Peel, fruit by hand remove pits.	Medium	,,	25	30	30
9. Mangoes	Peel, cut into slices of suitable size.	Light	Plain or Lacquered	12	15	15
10. Melon (Musk)	Peel, slice to suitable size, discard seeds.	Medium	Plain	30	35	35
11. Peaches	Soften skin by dip in boiling water cool quickly in cold water. Remove skin, halve, pit and slice, if desired.	Heavy or Medium	,,	25	30	20
12. Pears	Peel, halve, and remove cores.	Medium				

Fruit	Methods of preparation	Syrup strength*	Kind of can	Cooking time in minutes in boiling water—212° F.* Size of can 1 lb. butter	A2½	Glass jars pint
1	2	3	4	5	6	7
13. Pine-apples	Remove outer fibrous coating, cut transversely into ½" slices, remove eyes and core.	Heavy or Medium	,,	12	15	15
14. Papaya	Peel, slice to suitable size, discard seeds.	*Medium*	,,	35	40	35
15. Plums	Pick fruit.	Medium	Lacquered	15	20	15
16. Strawberries	Stem, add ½ cup (8 oz.) sugar per 2 lbs. fruit; bring slowly to boil, let stand overnight bring quickly to boil before *packing.*	*Heavy*	,,	12	15	15
17. Tomatoes	Dip in boiling water for ½ minute then dip quickly in cold water to loosen skin. Trim stem ends and green portions, if any.		(see note plain)	50	55	45

***Syrup Strength**	**Sugar (cups)**	**Water (cups)**
Light	1	2
Medium	1	1½
Heavy	1	1

PREPARATION OF ORANGE MARMALADE

1. **Selection of fruit:**—'Maltas' (Tight skinned oranges) and 'Khattas' (rough lemons) are suitable fruits for proper acidity and pectin. Even fruits of inferior quality but sound otherwise (i.e. lacking in their normal juice content) can be used for the purpose. Two 'Maltas' are used for every 'Khatta'.

2. **Preliminary treatment:**—Wash the fruits thoroughly to remove dust, sprays etc. in cold running water.

3. **Preparation of fruit:**—This method described below is based on the experimental work done in the Fruit Product Laboratories at Lyallpur under the auspices of the Indian Council of Agricultural Research. Carefully peel off the outer thin portion of the fruit with sharp, stainless peeling knives leaving as much of the albido portion intact as possible. Preserve the peel of about one third to one fourth the number of oranges for shreds, etc.

4. **Shredding of slices:**—The peels of tight skinned oranges preserved for shreds are cut into fine shreds with sharp cutting knives and then boiled in sufficient quantity of water for about 10 minutes and changing the water 2 or 3 times, if necessary.

5. **Extraction of pectin:**—Slice the peeled fruit into thin slices and add enough water to cover the same. Then cook the mass for about half an hour with occasional crushing by means of a wooden ladle till the extract shows good stickiness. Strain the hot pulpy extract through a coarse muslin cloth. To the pomace add 1/3 to 1 quantity of water and take the second and similarly, if possible, the third extraction. Mix all the three extracts together and discard the residual fruit pulp, keep the mixed extract overnight for sedimentation in deep vessel.

6. **Testing of pectin:**—To a teaspoonful of the clear extract add two teaspoonfuls of methylated or rectified

spirit. Formation of one big clot indicates the extract to be rich in pectin but small though many clots indicate medium pectin and a thin gelatinous precipitate shows poor pectin.

7. **Addition of sugar:**—To every cup of the clear extract add ½ and 3/4 cup of sugar respectively if the extract contains rich or medium pectin. In case, however, the extract is poor in pectin, concentrate the same till it gives good pectin test and then add the requisite quantity of sugar.

8. **Cooking:**—Cook the mixture to 218°F. (this temperature is reached just about 15-20 minutes before the end point at sea level) and add the boiled shreds of the orange peel. Continue boiling till the temperature reaches 222° F. or the product gives the sheeting test viz. it falls from the ladle in the form of flakes and not drops.

Note:—For every 500 feet, rise in altitude a decrease of 1° F. should be effected in the above cooking temperature.

9. **Packing and storage:**—Pour the product into clean, dry, sterilized glass jars and seal them air-tight after cooling. Store in a cool dry place.

PREPARATION OF LIME AND GREEN CHILLI PICKLE

1. **Selection of material:**—Select sound, fully mature (with deep yellow skin) juicy limes and good size local green chillies. If the limes are a bit greenish in appearance they should be allowed to develop that colour before being put to use.

2. **Preliminary treatment:**—Wash the lime and the chillies thoroughly in running cold water.

3. **Preparation of material:**—Remove the stalks of green chillies without injuring their caps and cut the

limes into halves or quarters depending on their size.

4. **Recipe:**—The following recipe has been evolved on the basis of the experimental works carried out in the Fruit Products Laboratories at Lyallpur and Delhi under the auspices of the Indian Council of Agricultural Research. For every pound of limes and green chillies used, weigh out four ounces of powdered salt and put it in a clean, sterilized wide mouthed glass or glazed jar. Partially squeeze the juice of limes over that salt and put the partially squeezed limes on to the same. Similarly give deep longitudinal incisions into the green chillies individually and add them to the same jar. Stir the mass well so as to effect a thorough mixing. If the juice of the limes does not cover the entire mass add boiled but cooled water acidified with citric acid (4-5%) so that the limes and the chillies are covered with the liquid.

5. **Further treatment:**—Keep the mass in the Sun with occasional shakings for about a week or so, so that the limes get softened (indicated by their skin turning light brown and the chillies turning from green to brown). The pickle at that stage is ready for use.

Note:—Care should be taken to keep off moisture from the pickle which otherwise would get mouldy and spoiled.

S. No.	Name of the Article	Qty.or No.	Approx. price
1	2	3	4
			Rs.
1.	Balance with small weights of 'tola' 'masha'	One	10
2.	Basket Press, laboratory type	One	100
3.	Basins (enamelled)	12	50
4,	Bottles (different sizes) according to requirements	—	—
5.	Brushes (bottle cleaning)	6	2
6.	Buckets (enamelled)	4	60

S. No.	Name of the Article	Qty.or No.	Approx. price
1	2	3	4
			Rs.
7.	Buckets (G.I.)	6	30
8.	Can and cork opener	2	1
9.	Cans (reformed) (30 oz. 16 oz. butter, 16 oz. milk) according to requirements	—	—
10.	Can sealer (Burpee type) with spare parts	1	250
11.	Carboys (glass) 40 lbs. capacity	1	50
12.	Citric acid accoding to requirements	per lb.	3
13.	Citrus oil extracting plate	1	50
14.	Colours (edible)	2-3 ozs.	1
15.	Cooking pans (Aluminium)	6	20
16.	Corks ordinary according to requirements and size	—	—
17.	Crown corks according to requirements and size	—	—
18.	Crown corking machine	1	100
19.	Cups (enamelled)	2	5
20.	Cylinders (graduated)	3	10
21.	Cylinders (ungraduated)	3	10
22.	Essences and essential oils (according to requirements)	—	—
23.	Family balance	1	50
24.	Funnels (enamelled)	2	3
25.	Glass jars (screw cap) according to requirements	—	—
26.	Gloves (rubber)	4 pairs	15
27.	Hearths (charcoal)	2	8
28.	Home Drier (cabinet type 3'x2'x3'(with six spare trays	1	400
29.	Hydrometers (brix) all ranges from 0°-90	1 set	75

S. No.	Name of the Article	Qty. or No.	Approx. price
1	2	3	4
			Rs.
30.	Ladles (Wooden)	6	5
31.	Lime Juice squeezers	1 doz.	10
32.	Mix Master (juice extractor and mixer)	1	300
33.	Plates (enamelled)	6	10
34.	Potassium metabisulphite (according to requirements)	per lb.	7
35.	Pressure cooker (Burpee type)	1	300
36.	Salometer	1	15
37.	Screw type juice extractors	2	100
38.	Sieves (1 mm. mesh)	2	5
39.	Sodium benozoate according to requirements	per lb.	4
40.	Spirit lamps	2	10
41.	Spirit (methylated or rectified)	1 lb.	2
42.	Stainless steel knives of all kinds (cutting, peeling, coring and pitting)	1 doz. each	150
43.	Stove (kerosine, primus)	1	15
44.	Stove (Electric)	1	15
45.	Thermometers	2	30
46.	Tumblers (glass)	6	3
47.	Vacuum gauge	1	40

Note:—1. Prices, as given above, are only approximate in view of the fact that they will keep on changing.

2. Cans and can sealing equipment can be secured from the Metal Box Co. of India, Calcutta or through any of the branches in Madras, Bombay or Delhi.

3. Items of machinery including knives, etc. can be had from Food Machinery suppliers

M/s. Gladwyn & Co., Hornby Road, Bombay or Gardners Corporation. Connaught Circus, New Delhi.

4. Chemicals and Laboratory equipment may be available from all scientific stores.

5. Other items of every day use can be purchased from Hardware or General merchants in the local market.

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